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Source localization of the effects of Persian classical music forms on the brain waves by QEEG

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Abstract

The aim of this study is investigation of the effects of Persian classical music forms on the brain waves and areas. Main tool was QEEG that registers brain waves. Independent variables include four classical music forms: Pishdaramad, Chaharmezrab, Reng and Avaz that their effects have been investigated on the 12 right handed subjects. The results indicated significant differences in the effects of Pishdaramad form on the theta band while it could affect on different brain areas in comparison with other music forms including the increase of activity in Superior Frontal Gyrus and Precentral Gyrus areas in comparison with noise and Avaz and decrease of activity on Postcentral Gyrus and Supramarginal Gyrus areas in comparison with Chaharmezrab and Reng. The results concluded from rhythmic changes in each of music forms. In other word the increase of rhythm speed can raise the brain activity. Also the results of this study shows important of frontal area during the processing of emotional music.

Keywords: Persian classical music forms, brain areas, brain waves, emotion, rhythm, QEEG

1. Introduction

During the past years, neurological studies represented that music is a valuable instrument to examine the emotions (Koelsch, 2005). Studies showed that different emotional responses can be established by manipulating and simply changing the basic characteristics of music (Gomez & Danuser, 2007). Two elements of melody, especially rhythm and tempo are fundamental components of music to express the emotions (Krumhansl, 2000). The basic features of music have the major role in creating emotional responses, while the other peripheral parameters of music have less effect on emotion (Gomez & Danuser, 2007). Hyde and Scalapino (1918) believe that minor and major scales are involved in the physiological influencing process, on the contrary, Bernardi et al. (2005) believe that the whole part of music are not of our concern since it is the tempo that is crucial in defining physiological response. On the other hand, Limb (2006) believes that rhythm is not only for creating the time basis but also it is the building block of any musical element.

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Considering the importance of rhythm and tempo, shapes and forms of Persian classic music are of our concerns that create rhythm and tempo with the same intervals. Five basic forms of Persian classic music are: Pishdaramad, Chaharmezrab, Avaz, Tasnif, and Reng. The first part of these forms is "Pishdaramad" that usually includes a special tranquility. Performance rhythm of Pishdaramad is usually 2/4. Chaharmezrab is a kind of instrumental performance that sophisticated compositions can be constructed by its basis and usually includes combined rhythms of 6/8. Avaz is the most important part of these forms that has nothing to do with rhythm and tempo. Reng is also an instrumental piece of music that usually contains a lively rhythm of 6/8.

Two studies were carried out on 12 musicians and 12 non musicians using EEG to examine the effects of basic components of classical music (Tempo, Melody, and Key). By changing the tempo in the first study, both groups represented reduced alpha in the left hemisphere (F3) compared with the right hemisphere. By changing melody, alpha activity in non musicians was more localized in the right hemisphere (f4), while no localization was observed in musicians. In the second study, changes in the intervals key and their effect on the quality of brain waves of two groups of 18 musicians and non musicians were examined. Findings showed that by changing the intervals, alpha is reduced more in right hemisphere (F4) in the frontal areas compared with the left hemisphere. On the other hand, in spite of key change's notification, musicians showed more reactions to key changes compared with non musicians (Overman et al., 2003). Findings of Khalfa et al. (2005) represented that minor scale causes more activities in left orbito posterior cingulated cortex and mid-dorsolateral frontal cortex compared with major scale. Since two minor and major scales in the form of slow and quick tempo were used in this study, findings showed that arousal level of both scales is the same. At the end of this study, it will be mentioned that the role of scale and tempo in emotional distinguishing process at least depends on the activity of two areas, namely, orbito frontal and singulate cortex that are involved in emotional processing of the other modalities. The study carried on with EEG showed the different characteristics of active models of brain cortex. In this study, positive emotional music showed more localization in the left hemisphere of frontal-temporal cortex while negative emotional music conforms to this model in the right hemisphere (Davidson et al., 1979). According to the findings, sorrowful music stimulus results in increased activity in the temporal structures of the left hemisphere (Mitterschiffthaler et al., 2007).

Since Persian musical forms are performed in different rhythmic frameworks, we intend to examine the induction effects of these states on the brain reaction with emphasis on the brain waves. Therefore, the aim of this study is to examine different states of forms and aroused effects of brain while listening to different forms of Persian classical music.

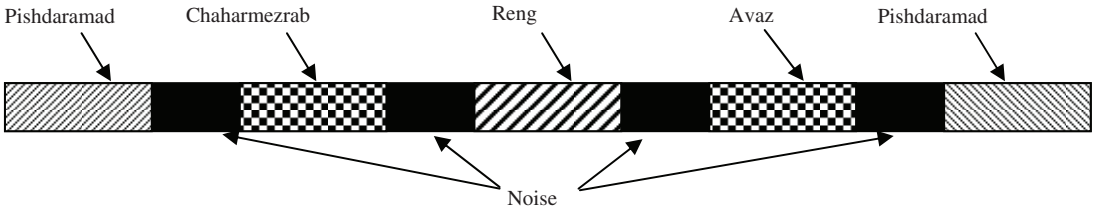
2. Method

2.1. Participants

The sample of this study includes 12 (9males, 3females) right-handed non musician students of 20-30 years old (average: 26 years old).

2.2. Materials

In this study, three beating forms of Pishdaramad, Chaharmezrab, and one Avaz form were used. Beating per minute (bpm) for Pishdaramad was 43bpm, for Chaharmezrab, 133bpm and for Reng, 132bpm. Test design was according to four active blocks with one minute timing for every piece of music that 20 seconds noise was applied among every piece of music to eliminate the influence of the former piece. In general, by twice performing, testing time was about 10/40. (See the following figure)



2.3. Procedure

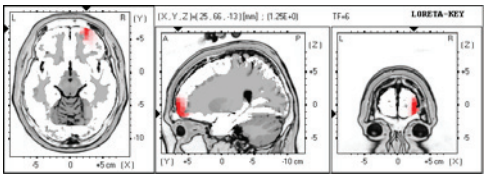
QEEG: the data was recorded by the use of an Italian digital amplifier by the name of EBNEURO and a hat that according to the international rules measures 21 positions on head. The data was recorded by LINK EAR assembly.

The electrodes under examination contained F3, F4, F7, F8 (as frontal lobe), C3, C4, C2 (as the central area), T3, T4, T5, T6 (as temporal lobe) P3, P4, P2 (as parietal lobe) and O1, O2 (as occipital lobe).

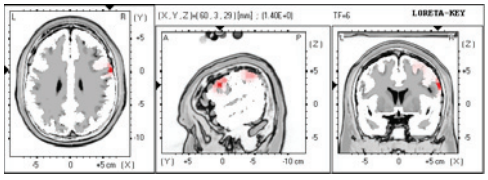
LORETA: Low resolution brain electromagnetic tomography (LORETA) is a method that determines three dimensional distributions of brain waves on the basis of mathematical formulas. In this method, brain waves obtained from EEG on standard MRI images are superimposed and it shows the results as red colors (increasing the activity) and blue (decreasing the activity) on MRI.

3. Results

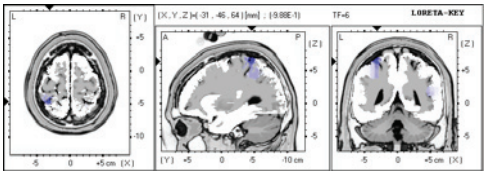
Considering the meaningfulness of theta differences in different forms, LORETA was used for locating these differences. Visual display of brain in sub cortical level in theta band from left to right includes three axis of axial, sagittal, coronal respectively that were examined with regard to the meaningfulness of Pishdaramad differences with the other tests (p, 0.05). According to first two images from the following images, comparing noise and Avaz, Pishdaramasd produces more activity intensity in theta wavelength(red spots) that engages some areas of frontal lobe in both pieces of the music while during the comparison between Chaharmezrab and Reng, Pishdaramad was accompanied by reduced activity of theta in some areas of parietal lobe(blue spots). Brain areas involvement with noise in comparative parts of Pishdaramad includes the activities in Precentral Gyrus area, for Avaz, the activities in Superior Frontal Gyrus, for Chaharmezrab, Supramarginal Gyrus and for Reng, the activity in Postcentral Gyrus is influenced.



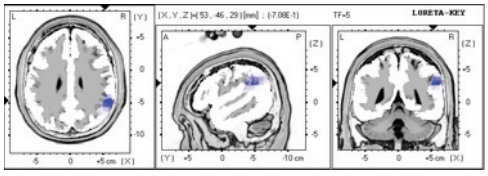
Pishdaramad-Avaz



Pishdaramad-Noise



Pishdaramad-Reng



Pishdaramad-Chaharmezrab

BA	Z	Y	X	Areas	Persian Music Forms
6	29	3	60	Precentral Gyrus	Pishdaramad-Noise
11	-13	66	25	Superior Frontal Gyrus	Pishdaramad-Avaz
40	29	-46	53	Supramarginal Gyrus	Pishdaramad-Chaharmezrab
5	64	-46	-31	Postcentral Gyrus	Pishdaramad-Reng

Figure 2. Activity brain areas in the music task that is showed in three axels (X,Y,Z) and in Bradman regions

4. Conclusion

The examination of the effects of four performance forms of this study depends on the type of rhythm and tempo that were variable during the performance of all four forms. Findings showed that increasing the rhythm in melody,

results in the increased arousal of different levels of brain. The results obtained from the active areas of theta band represented that processing of Pishdaramad has a free rhythm and neutral noise pieces are accompanied by maximum amount of brain activity compared with Avaz while the same form is accompanied by reduced brain activity compared with two forms of Chaharmezrab and Reng that have a high beating speed compared with Pishdaramad. Moreover, by examining the active areas of theta band, Superior Frontal Gyrus located in prefrontal and Precentral Gyrus was parts of posterior-frontal of brain that are active in both conditions of noise and Avaz.

It is believed that prefrontal cortex constantly becomes active during emotional activities compared with the other structures of the brain. Researchers suggest that this area of the brain is generally determining the internal and external emotional signals (Phan et al., 2002). The fact is that by increasing rhythm and tempo of the music, the emotional induction is increased (Gomez & Dancer, 2007) and this influencing model of this study implies that the rhythmic piece of Pishdaramad produces activities in frontal area compared with two pieces of noise and Avaz that don't produce any sort of rhythmic interferences. During this study, we observed decreasing activity of parietal in brain areas of Supramarginal Gyrus and Postcentral Gyrus while comparing Pishdaramad with two pieces of rhythmic Chaharmezrab and Reng. It is worth mentioning that the beating speed in two pieces of Chaharmezrab and Reng is so much higher than Pishdaramad. According to the model provided by Heller (1993), when the music is very emotional, the parietal areas are more active while this area along with Pishdaramad that has lower beating speed compared with the other two forms, are less active. The findings of this study with emphasis on previous studies showed that rhythm and tempo are the primitive and major elements in inducing physical changes of the brain, that's why different levels of brain can be changed by manipulating one of the elements of rhythm and tempo.

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